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(54) **A milling cutting insert and a milling cutter**

(57) The present invention relates to a milling cutter. The milling cutter comprises a holder and cutting inserts. The holder has a fastening device (33), a pocket comprising at least radial shoulder. The cutting insert (10) has an octagonal basic shape and includes eight cutting edges (16) created by the transition between an upper face (11) and an edge face (13) of the insert (10). The upper face (11) comprises a number of projections. A portion of the projection facing away from the associated cutting edge (16) is provided to abut against a fastening device (33) if the insert (10) is radially moved during milling. The invention further relates to a cutting insert (10), per se.

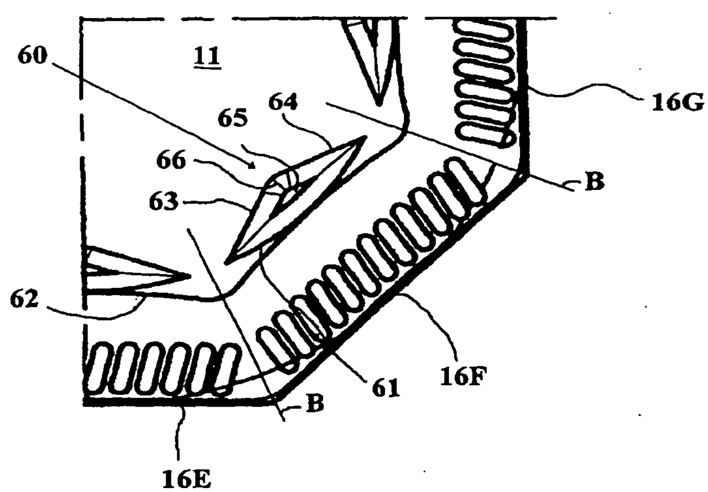

FIG. 2G

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a cutting insert and a milling cutter according to the preambles of the independent claims.

BACKGROUND OF THE INVENTION

[0002] In tools for metal cutting having indexable cutting inserts of hard and wear resistant material the cutting edges are subjected to wear and sometimes some part of or the entire cutting edge collapses. If a small insert fractures only the cutting edge collapses without any risk for damage to the tool body. If a large insert fractures, the risk of damage to the tool body increases to an essential degree. If the cutting insert is not seated on a shim then a fracture of the insert often gives rise to damage of the tool body. To avoid such damages it is usual that the cutting insert rests on a shim of cemented carbide. A usual combination is a cutting insert having a thickness of about 5 mm and a shim having a thickness of 3 - 5 mm. This results in a total thickness of the cutting insert and the shim of 8- 10 mm.

[0003] In US-A-5 147 158 there is depicted a four-sided cutting insert having an integrated shim so as to provide a fracture zone. The cutting insert comprises an upper rake face, a lower face, and an edge clearance face interconnecting said upper and lower faces. The edge clearance face includes a step located intermediate the upper and lower faces. When the insert is in use the step defines a zone with a strain peak such that in the event of insert breakage, the propagation of the crack will be guided to the area of the step. The portion of the insert located below the step remains intact and thus protects the tool body.

[0004] US-A-4,966,500 shows a milling cutter having octagonal or hexagonal cutting inserts. Each cutting insert has a segmented (non-linear) major cutting edge, an end cutting edge and a radially inner cutting edge. The radially inner cutting edge is supposed to cut during coring of the work piece. The known insert lacks fracture zones so as to prevent an insert breakage from transferring into the seat or shim. During use of such a known insert it has happened that the insert has been thrown radially outwardly due to excessive centrifugal forces thereby creating hazards for the environment.

OBJECTS OF THE INVENTION

[0005] One object of the present invention is to present a cutting insert and a milling tool that overcome the disadvantages discussed above.

[0006] Another object of the present invention is to provide a cutting insert and a milling tool providing a safe environment when in use.

[0007] Still another object of the present invention is to provide an economically favorable cutting insert providing six or eight edges.

[0008] These and other objects are realized by a milling cutter and a cutting insert that has been given the characteristics of the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The objects and advantages of the invention will become apparent from the following detailed description of a preferred embodiment thereof in connection with the accompanying drawings, and in which:
Fig. 1A shows an embodiment of a milling cutter according to the present invention, in a side view. Figs. 1B and 1C schematically show two possible positions of the insert in the milling cutter body. Fig. 2A shows a plan view of a cutting insert according to the present invention. Fig. 2B shows a section along line E-B in Fig. 2A. Fig. 2C shows the insert in a side view. Fig. 2D shows a magnified portion of a lower comer of the insert in Fig. 2B. Figs. 2E and 2F show cross-sections according to the lines E-E and F-F, respectively in Fig. 2A. Fig. 2G shows a magnified quarter of the insert of Fig. 2A.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

[0010] In Fig. 1A is shown a milling cutter 30 according to the present invention, including a tool holder 31 and cutting inserts 10. The holder 31 is a milling cutter body which has a number of pockets 32 for receiving cutting inserts. Each pocket comprises a substantially planar base 40 and two shoulders; one axial 42 and one radial shoulder 43 (Fig. 1C). The shoulders are substantially perpendicular to each other. Each shoulder includes a first surface, provided to abut a corresponding first portion 13a of the insert 10. A threaded boring is provided in the vicinity of the pocket 32 so as to receive a fastening screw 33 to force the insert towards the shoulders and the base, via a radially outer part of the screw head. When the insert is to be indexed the screw 33 is partially unscrewed until the cutting insert can be pulled by hand radially outwardly and the insert may be rotated by an increment corresponding to 45° counterclockwise, so that a fresh secondary cutting edge 16E comes in position. Then the insert is pushed into the pocket and the screw is tightened again. The edge 16D is preferably passive and does not cut during milling. The inserts 10 will be located in the holder at a setting angle Q about 43°, to obtain a clearance angle of about 2° for the secondary cutting edge 16E of the insert 10.

[0011] The cutting insert 10 depicted in Figs. 2A to 2D has a generally octagonal basic shape and includes an upper face 11, a lower face 12 and an edge face 13 generally connecting the upper and lower faces 11 and 12, respectively. The cutting insert 10 has a positive geometry, i.e., an upper portion 13a of the edge face defines a clearance face and forms an acute angle with the up-

per face 11, the latter being a rake face. The upper face 11 includes a chip upsetting face 14 located at the periphery of the insert 10. The upper face 11 furthermore, includes a chip face 15 sloping inwardly and downwardly from the chip upsetting face 14. The latter faces constitute the most peripheral part of the upper face 11. The intersecting line between the chip upsetting face and the edge face 13 forms the overall cutting edge 16, which is defined by eight cutting edges 16A-16H. The chip face 15 is concavely curved and extends inwardly from the chip upsetting face from a transition edge 26 therewith. A ridge is provided at each intersection of the chip faces 15 so as to strengthen the corner 34 and to form the chip generated at the corner 34. A plurality of projections or preferably depressions 25 are formed in the chip face 15, the projections or depressions 25 being spaced apart along the transition edge 26. The depressions 25 preferably intersect the transition edge and extend inwardly therefrom in a direction non-perpendicularly to the associated cutting edge 16 as said insert is viewed in plan. Each depression thereby forms in plan, an angle in the range of 15° to 40° relative to a normal of the associated clearance face 13. The effect of such design is to minimize heat transfer from the chip to the insert.

[0012] Respective pairs of adjacent cutting edges 16 meet to form a cutting corner 34 having an internal obtuse angle, about 135°. Each cutting edge is in a bottom view, generally parallel to the adjacent second portion 13b of the shim 22. Each cutting edge is concavely curved when seen in a side view, such that the mid section of the edge is closer to the lower side 12 than are the end sections thereof.

[0013] The edge face 13 includes eight segments. An upper portion 13a of each segment of the edge face 13 forms a clearance angle α with a plane P oriented parallel to a center axis 20 of the insert (Fig. 2B). The clearance angle α is at least 20°, preferably at least 25°. The distance between two diametrically opposed major cutting edges 16C and 16G for example is depicted by numeral L1 in Fig. 2A. The distance L1 is the same for all combinations of diametrically opposed major cutting edges.

[0014] The eight, planar edge surfaces 13 taper towards the lower face 12 and generally intersect at the center line 20 of the cutting insert 10 below the lower face 12.

[0015] Each segment of the edge face 13 is provided with an inward, downwardly facing shoulder forming a step 18. The upper or first portion 13a of the segment is located above the step 18 has a positive geometry in order to provide the necessary clearance angle. A lower or second portion 13b of the segment forms a peripheral edge of a shim 22 which is of integral one-piece construction with the upper part of the insert. The shim 22 forms the lower face 12 of the insert. The second portion 13b of each segment has a negative geometry, i.e. the second portion 13b is perpendicular to the lower face 12 and thus form no clearance angle. Each second portion 13b lies radially inside of an imaginary extension of the associated first portion. That is, the edge surface does not need to be ground if the clearance face is ground and thereby saving energy. Furthermore the step 18 will then be sufficiently large in the radial direction to provide for a favorable control of any cracks emanating during machining. The step 18 thus provides a sharp inner corner 19 that constitutes an exit zone for a fracture that by a possible break of the cutting edge controls the break and leaves the lower portion of the cutting insert undamaged. By the term "sharp" is here meant that the corner is intentionally weakened by having a radius of 0 to 0.3 mm, preferably about 0.2 mm. The second or lower portion 13b thus protects the tool body.

[0016] Directing attention to Fig. 2B and 2D the following is to be said. The height h_1 is 15 - 60% of the insert height h, preferably about 25%. This is possible since the anvil or shim constitutes an integral part of the cutting insert 10, i.e. the height h_1 corresponds to the height of the integrated shim 22. In order to achieve a good function of the cutting insert 10 it is necessary that the height h_1 does not constitute too big a part of the height h since in that case the strength of the cutting edge will be too low. That could result in fractures of the cutting edge also at small loads. The smallest radial distance d from the step 18 to the second portion 13b in the plane of the lower face 12 depends on the clearance angle. The distance d in Fig. 2D, is in the interval 0.01-1.0 mm, preferably in the magnitude of 0.1 mm.

[0017] The second portion 13b is about parallel with the center axis 20. The step 18 forms an angle δ with a line perpendicular to the center axis 20. The angle δ is 0° to 30°, and preferably about 20°.

[0018] Eight second portions 13b are formed around the periphery of the shim 22. Two adjacent portions 13b meet in a corner 23 at an internal obtuse angle, about 135°. The corners project radially relative to the rest of the second portions 13b. The periphery of the lower part describes a path of increasing and decreasing radial distances from the center axis 20 of the insert.

[0019] The upper face 11 furthermore, includes a number of projections 60. Each projection 60 is associated with an adjacent cutting edge 16. Each projection 60 is provided radially inside the chip face 15 and thus the projection 60 is provided substantially radially inside the step 18. The projection 60 does not intersect the bisectors B of the adjacent corners 34 so as to facilitate the alternative use of a wedge for holding the insert in stead of the screw 33. In a top view (Fig. 2G) the projection 60 is of a generally triangular shape. The base 61 of the triangle is somewhat convex and preferably touches a radially inner edge 62 of the chip face 15. The base 61 is connected to substantially identical flanks 63, 64. The flanks 63, 64 and the base 61 upwardly away from the surface 11 connect to a substantially planar surface 65, which is of smaller area than the area at the intersection of the surface 11 and the projection 60. The flanks 63, 64 are mutually connected along a ridge 66,

which is supposed to abut against the screw 33 under certain circumstances, see explanation below. The height Z of the projection 60 is about 0.1-0.3 mm.

[0020] In Fig. 1B is shown how the insert 10 usually is clamped in the milling cutter body. That is, the first portion 13a of the insert 10 abuts against the radial shoulder 43 while resting on the base surface 40. If however, the frictional force between the screw 33 and the upper surface 11 is overpowered by centrifugal force the position shown in Fig. 1C arises. That is, the insert will travel radially outwardly until the ridge 66 of the projection 60 abuts against the screw 33. Any further movement of the insert will be stopped by the interaction between the projection 60 and the screw 33. The projection 60 thus safe-guards the insert from being thrown outwardly if the centrifugal force is sufficiently large. It should be noted that only the projection adjacent the passive edge 16C which faces towards the radial shoulder 43 performs a function during milling, while the other projections do not perform any function. By the term "passive" is here meant that the connected cutting edge is not in cutting position.

[0021] By applying the teachings of the present invention a cutting insert and a milling tool providing an economically favorable cutting insert having at least six cutting edges are provided. The milling tool is safe to operate. In addition, by providing the insert with an integral shim, defined by a sharp corner, the possible cracks will be stopped from propagating into the holder body. The present invention provides an economical solution to the user, by having eight cutting edges and by saving holder bodies. In addition, the tool according to the present invention cuts in an easy manner through the workpiece metal which is especially important when a thin flange shall remain connected to the work piece of aluminum, for example.

[0022] Although the present invention has been described in connection with a preferred embodiment thereof, it will be appreciated by those skilled in the art that additions, deletions, modifications, and substitutions not specifically described may be made without departing from the scope of the invention as defined in the appended claims. For instance, the insert 10 may alternatively have another polygonal basic shape such as square or hexagonal basic shape and thus the insert 10 will provide four or six cutting edges, respectively.

Claims

1. A milling cutting insert (10) having a generally polygonal basic shape and including at least four cutting edges (16) created by the transition between an upper face (11) and an edge face (13) of the cutting insert (10), said upper face (11) having a chip face (15) defining a rake face and said edge face (13) defining a clearance face, said edge face (13) forming a first clearance angle (α) with a plane (P) parallel to a center axis (20) of the insert, **characterized** in that the upper face (11) comprises a number of projections (60), each projection (60) being associated with an adjacent cutting edge (16) and in that each projection (60) is provided substantially radially inside the chip face (15) and in that a portion (66) of the projection facing away from the associated cutting edge (16) is provided to abut against a fastening device if the insert (10) is radially moved during milling.

2. The cutting insert according to claim 1, **characterized** in that the projection (60) does not intersect bisectors (B) of adjacent corners (34) and that the edge face (13) is provided with a step (18) which is provided so as to constitute an exit zone for a fracture and in that the projection (60) is provided substantially radially inside the step (18).

3. The cutting insert according to claim 1 or 2, **characterized** in that the projection (60) is of a generally triangular shape in a top view and in that a base (61) of the triangle is somewhat convex and preferably touches a radially inner edge (62) of the chip face (15).

4. The cutting insert according to claim 3, **characterized** in that the base (61) is connected to substantially identical flanks (63,64) and in that the flanks (63,64) and the base (61) upwardly away from the upper face (11) connect to a substantially planar surface (65), which is of smaller area than the area at an intersection of the upper face (11) and the projection (60) and in that the flanks (63,64) are mutually connected along a ridge (66), which is supposed to abut against a fastening device (33) under certain circumstances and in that the height (Z) of the projection (60) is about 0.1-0.3 mm.

5. The cutting insert according to claim 2, **characterized** in that the step (18) is so designed that in a certain longitudinal cross-section of the cutting insert the distance from a centre line (20) of the cutting insert (10) to the periphery of the cutting insert (10), said distance being perpendicular to the centre line (20), is smaller below the step (18) than above the step (18), and that the distance h_1 from the lower face (12) of the cutting insert (10) to the step (18) is 15 - 60 % of the distance h from the lower face (12) to the cutting edge (16), said step being provided so as to constitute an exit zone for a fracture radially inside the clearance face.

6. A milling cutter comprising a holder (31) and cutting inserts (10), said holder having a fastening device (33), a pocket comprising at least radial shoulder (43) and said cutting insert (10) having a generally polygonal basic shape and including at least four

cutting edges (16) created by the transition between an upper face (11) and an edge face (13) of the insert (10), said upper face (11) having a chip face (15) being a rake face and said edge face (13) being a clearance face, created at the transition of two adjacent cutting edges (16), said edge face (13) forming a first clearance angle (α) with a plane (P) parallel to a center axis (20) of the insert,
characterized in that the upper face (11) comprises a number of projections (60), and in that a portion (66) of the projection facing away from the associated cutting edge (16) is provided to abut against a fastening device (33) if the insert (10) is radially moved during milling.

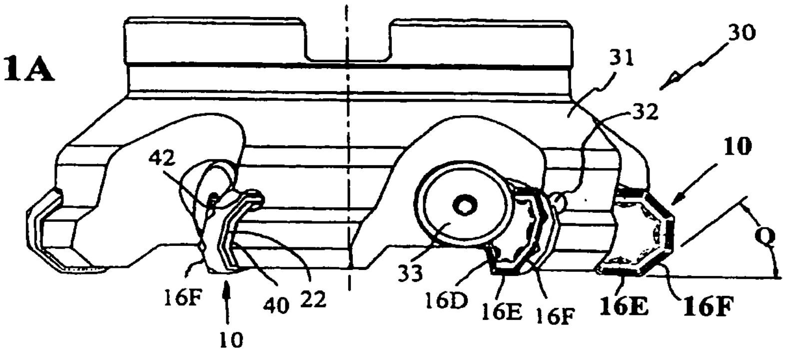
7. The milling cutter according to claim 6,
characterized in that each projection (60) is associated with an adjacent cutting edge (16) and in that each projection (60) is provided substantially radially inside the chip face (15) and that the edge face (13) is provided with a step (18) which is provided so as to constitute an exit zone for a fracture and in that the projection (60) does not intersect bisectors (B) of adjacent corners (34) and in that the projection (60) is provided substantially radially inside the step (18).

8. The milling cutter according to claim 6 or 7,
characterized in that the projection (60) is of a generally triangular shape in a top view and in that a base (61) of the triangle is somewhat convex and preferably touches a radially inner edge (62) of the chip face (15).

9. The milling cutter according to claim 8,
characterized in that the base (61) is connected to substantially identical flanks (63,64) and in that the flanks (63,64) and the base (61) upwardly away from the upper face (11) connect to a substantially planar surface (65), which is of smaller area than the area at an intersection of the upper face (11) and the projection (60) and in that the flanks (63,64) are mutually connected along a ridge (66), which is supposed to abut against a fastening device (33) under certain circumstances and in that the height (Z) of the projection (60) is about 0.1-0.3 mm.

10. The milling cutter according to claim 7,
characterized in that the step (18) is so designed that in a certain longitudinal cross-section of the cutting insert the distance from a centre line (20) of the cutting insert (10) to the periphery of the cutting insert (10), said distance being perpendicular to the centre line (20), is smaller below the step (18) than above the step (18), and that the distance h_1 from the lower face (12) of the cutting insert (10) to the step (18) is 15 - 60 % of the distance h from the lower face (12) to the cutting edge (16), said step being provided so as to constitute an exit zone for a fracture radially inside the clearance face.

FIG. 1A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16F
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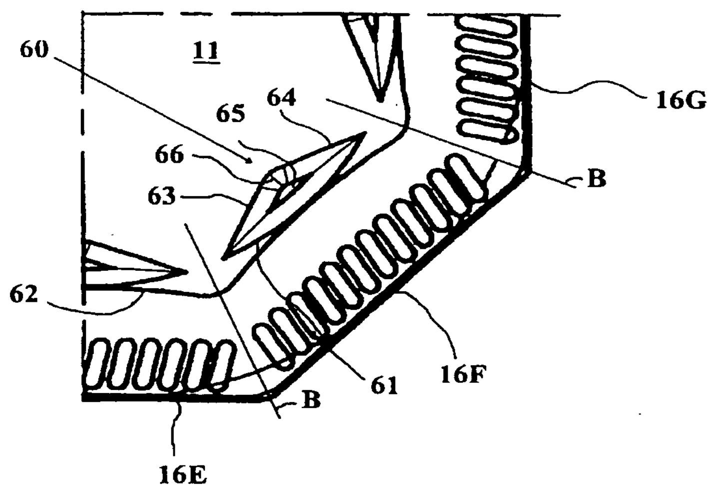
10
16D
16E
16F
16E
16F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16G
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16F
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16E

FIG. 2G

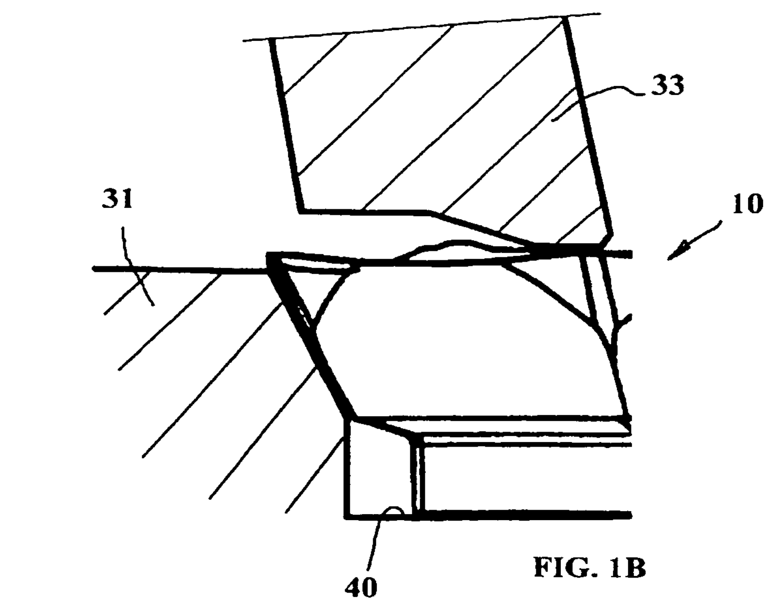

FIG. 1B

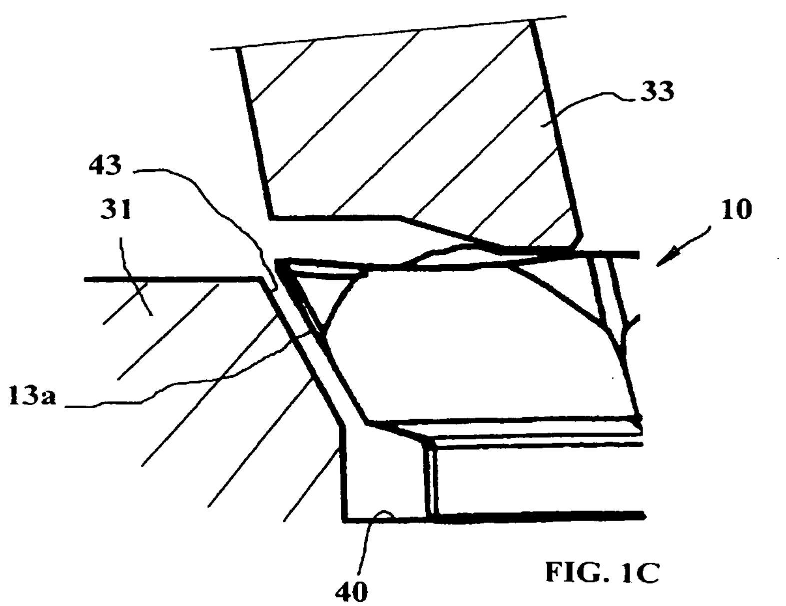

FIG. 1C

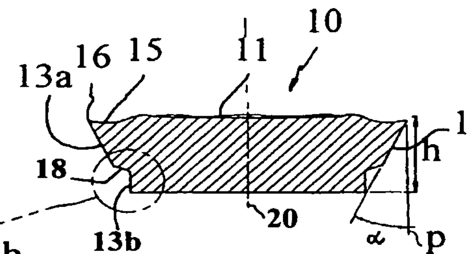

FIG. 2B

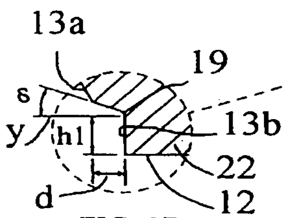

FIG. 2D

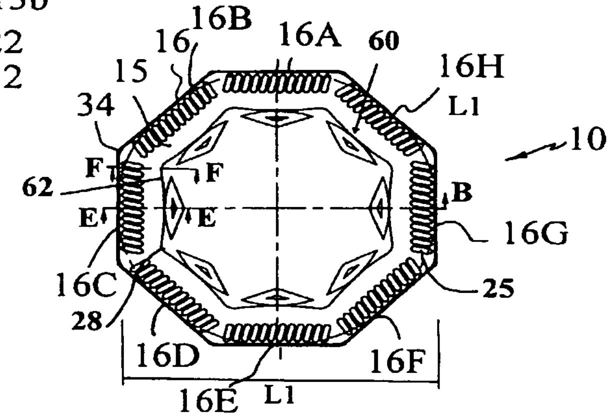

FIG. 2A

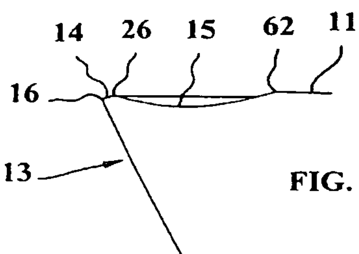

FIG. 2F

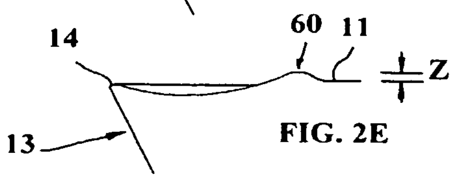

FIG. 2E

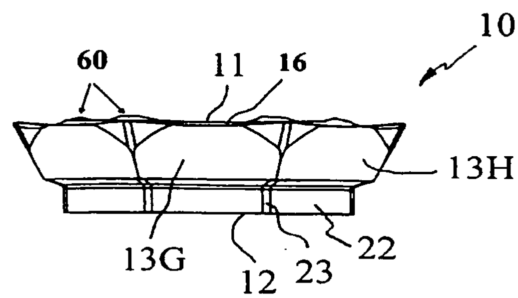

FIG. 2C